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Earth Observing System

Multi-angle
Imaging
Spectro-
Radiometer

Data Product Specification for the MISR Level 3 Component Global Aerosol Product

-Incorporating the Science Data Processing Interface Control Document

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-Incorporating the Science Data Processing Interface Control Document

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To determine the latest released version of this document, consult the MISR web site (http://misr.jpl.nasa.gov).

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Document Change Log

Revision	Date	Affected Portions and Description
	January 25, 2018	All, original release

Which Product Versions Does this Document Cover?

Product Filename Prefix	Version Number in Filename	Brief Description
MISR_AM1_CGAS	F15_0032	Level 3 Component Global Aerosol

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1 INTRODUCTION

1.1 MISR LEVEL 3 COMPONENT GLOBAL AEROSOL PRODUCT

The Multi-angle Imaging SpectroRadiometer (MISR) Level 3 Component Global Aerosol (CGAS) Product provides daily, monthly, seasonal, and yearly summaries of selected fields from the higher resolution (4.4 km × 4.4 km) MISR Level 2 Aerosol Product, on a global, geographic grid with a resolution of 0.5 degrees × 0.5 degrees. The Level 2 aerosol retrievals are based on observations from the MISR instrument onboard the National Aeronautics and Space Administration (NASA) Terra Earth Observing System (EOS) satellite, which has been operational since early 2000. The Level 3 CGAS products are distributed in NetCDF-4 format, which is designed to be interoperable with HDF5.

The purpose of this document is to describe the format of the MISR Level 3 CGAS Product. The full details of the other MISR standard products, as well as the ancillary datasets used in their generation, can be found in their respective MISR Data Product Specifications Documents (and, for earlier versions of the products, in the MISR Data Products Specifications Document, Rev. S). Information concerning the MISR georegistration is contained in the MISR Science Data Product Guide. The Level 3 CGAS Product summarizes the content of the MISR Level 2 Aerosol Product, which is distributed with a ***Data Quality Statement*** that summarizes the strengths and known limitations of that product, and is an essential complement to the current document for scientific users of the data.

1.2 MISR DATA PRODUCTS

The MISR project is a component of the EOS Terra Mission and the EOS Data and Information System (EOSDIS), which are components of NASA's Earth Science Enterprise. An integral part of the MISR project is the Science Data Processing (SDP) of the observations coming from the MISR instrument on-board the EOS Terra satellite.

MISR SDP exists to produce science and supporting data products from MISR instrument data. All functions of the MISR SDP system are directed toward this goal. MISR SDP does not operate as an independent entity, but rather is linked to the functionality of the EOSDIS at the Langley Research Center (LaRC) Distributed Active Archive Center (DAAC). The EOSDIS Core System (ECS) ingest subsystem at the LaRC DAAC is the agent for receiving and organizing all of the input data needed by MISR SDP. These data are then made available to MISR SDP through the data server and staging facilities provided by ECS at the LaRC DAAC. After MISR standard data processing is complete, the standard output products are archived through the EOSDIS data server and made available to users through ECS client services.

The MISR Science Computing Facility (SCF) at the Jet Propulsion Laboratory (JPL) supports the development of MISR science algorithms and software, instrument calibration and performance assessment, as well as providing quality assessment and data validation services with respect to MISR SDP. The MISR SCF is used to produce software, supporting data, and

coefficients that are required to operate MISR SDP software at the LaRC DAAC. Additional algorithm development, calibration, and validation support for the Aerosol Product is provided by the Climate & Radiation Laboratory at the NASA Goddard Space Flight Center (GSFC).

MISR SDP depends upon the availability of MISR instrument data, internal data sets produced at the MISR SCF, and external data sets that are products of other EOS data processing systems.

1.3 CONTROLLING DOCUMENTS

1) MISR Data System Science Requirements, JPL D-11398, September 1996 (or latest version).
2) MISR Level 1 Radiance Scaling and Conditioning Algorithm Theoretical Basis, JPL D-11507, Revision D, January 1999 (or latest version).
3) MISR Level 1 Georectification and Registration Algorithm Theoretical Basis, JPL D-11532, Revision D, November 1999 (or latest version).
4) MISR Level 1 Cloud Detection Algorithm Theoretical Basis, JPL D-13397, Revision A, November 1997 (or latest version).
5) MISR Level 1 In-flight Radiometric Calibration and Characterization Algorithm Theoretical Basis, JPL D-13398, June 1996 (or latest version).
6) MISR Level 1 Ancillary Geographic Product Algorithm Theoretical Basis, JPL D-13400, Revision B, March 1999 (or latest version).
7) MISR Level 2 Aerosol Retrieval Algorithm Theoretical Basis, JPL D-11400, Revision G, March 10, 2008 (or latest version).
8) MISR Level 2 Ancillary Products and Datasets Algorithm Theoretical Basis, JPL D-13402, Revision A, December 1998 (or latest version).
9) MISR Science Data Product Guide, JPL D-73355, April 2012 (or latest version).

1.4 APPLICABLE DOCUMENTS

10) SDP Toolkit Users Guide for the ECS Project, HAIS 194-809-SD4-001 (or latest version)

2 MISR LEVEL 3 COMPONENT GLOBAL AEROSOL DATA PRODUCT SPECIFICATION

2.1 MISR LEVEL 3 COMPONENT GLOBAL AEROSOL PRODUCT FILE NAMES

MISR Level 3 CGAS Products are composed of one of the six file types listed below (Table 1).

Table 1 – MISR Level 3 Component Global Aerosol Product File Names

MISR CGAS Product Granule Name*	ESDT Name
MISR_AM1_CGAS_mmm_dd_yyyy_Fff_vvvv.nc	MIL3DAEN
MISR_AM1_CGAS_mmm_yyyy_Fff_vvvv.nc	MIL3MAEN
MISR_AM1_CGAS_sss_yyyy_Fff_vvvv.nc	MIL3QAEN
MISR_AM1_CGAS_yyyy_Fff_vvvv.nc	MIL3YAEN
MISR_AM1_CGAS_FIRSTLOOK_mmm_dd_yyyy_Fff_vvvv.nc	MI3DAENF
MISR_AM1_CGAS_FIRSTLOOK_mmm_yyyy_Fff_vvvv.nc	MI3MAENF
MISR_AM1_CGAS_FIRSTLOOK_sss_yyyy_Fff_vvvv.nc	MI3QAENF
MISR_AM1_CGAS_FIRSTLOOK_yyyy_Fff_vvvv.nc	MI3YAENF

2.2 MISR LEVEL 3 COMPONENT GLOBAL AEROSOL PRODUCT FILE BRIEF DESCRIPTION

The MISR Level 3 CGAS Product summarizes the content of fields from the MISR Level 2 Aerosol Product averaged over a day, month, season, or year; reported on a global latitude-longitude grid of 0.5° × 0.5°. Only those fields whose retrievals pass all quality tests, defined by having the Aerosol_Retrieval_Screening_Flags field set to 0 (*pass all*) in the Level 2 Aerosol Product, are used in summary calculations. As a consequence, both Greenland and Antarctica are excluded from the Level 3 Product, due to the typically poor quality of MISR aerosol retrievals in these regions. Unscreened retrievals are available in the *4.4_KM_PRODUCTS/AUXILIARY* group of the Level 2 Aerosol Product, but ***users are strongly cautioned against the use of these fields without an appropriate understanding of their contents***. Fields that pass all the quality tests can be used with greater confidence, and are likely sufficient for most research purposes.

* Where mmm is the three character month (one of “JAN”, “FEB”, “MAR”, “APR”, “MAY”, “JUN”, “JUL”, “AUG”, “SEP”, “OCT”, “NOV”, “DEC”), sss is the season (one of “WIN”, “SPR”, “SUM”, “FALL”), dd is the two-digit day (e.g., “03”), yyyy is the four-digit year (e.g., “2002”), ff is the two-digit format version number (“15” for this version), and vvvv is the data version number (“0032” for this version).

In the Level 3 CGAS Product averages within a 5° × 5° latitude-longitude grid cell are calculated with every 4.4 km × 4.4 km Level 2 sample assigned equal weight, without regard to temporal sampling frequency. For example, if a grid cell has 90 samples with value 1.0 on day one, and 10 samples with value 2.0 on day two, the resulting average would be:

$$\frac{(90 \times 1.0) + (10 \times 2.0)}{90 + 10} = 1.1$$

2.3 DIFFERENCES BETWEEN FIRSTLOOK AND FINAL PROCESSING

The MISR processing stream has been split into two parts – "FIRSTLOOK" and "FINAL" – to accommodate the time dependence of the Terrestrial Atmosphere and Surface Climatology (TASC) and Radiometric Camera-by-camera Cloud mask Threshold (RCCT) ancillary datasets. The TASC contains snow-ice coverage and mean near-surface wind speed values that are updated on a monthly basis. The RCCTs are updated based on observations within a 3-month period. Rather than delaying processing of all MISR Level 2 and Level 3 data until these datasets are available, FIRSTLOOK products are generated using the TASC from the same month for the previous year and the RCCT from the same season in the previous year. When the updated TASC and RCCT datasets become available, FINAL processing is run. The FIRSTLOOK products are distinguished by the presence of FIRSTLOOK in the filenames, whereas FINAL products do not include any such designation (see Table 1).

2.4 FILE CONTENT DESCRIPTION

Content within each product file is organized as a hierarchy of groups, beginning with an unnamed top-level group. Each group can contain attributes, dimensions, or fields. Table 2 gives an overview of all groups with cross references to subsequent tables describing the content of each group.

Table 2 – Overview of File Content

Group Name	Description	Cross-references
(top-level, unnamed)	Top-level group, containing file attributes.	Table 3 and Table 4 (file attributes)
Aerosol_Parameter_Average	Contains parameter averages on 0.5° × 0.5° latitude-longitude grid.	Table 5 (dimensions) Table 6 (fields)
Source_file	Contains a list of input products used.	Table 7
Time_of_Observations_Aerosol_Parameter_Average	Lists observation times represented within each 0.5° × 0.5° latitude-longitude grid cell.	Table 8
HDFEOS_INFORMATION	Contains ECS Inventory Metadata, used by the DAAC, for ingesting, cataloging, and searching data products.	

Table 3 – NetCDF Climate and Forecast (CF) Standard File Attributes

Attribute Name	Value
title	MISR Level 3 Component Global Aerosol Product
institution	MISR Level 3 Component Global Aerosol Products are produced by the MISR Science Team using processing and storage facilities of the NASA Langley Research Center DAAC.
source	Aerosol retrievals are obtained from the MISR Level 2 Aerosol Products.
history	<*date*> : Initial production using software version <*version tag*>, built <*build date*>, by <*user id*>. See also Software_version_information and Input_files.
references	Data Product Specifications and Algorithm Theoretical Basis Documents are available from the Langley Atmospheric Science Data Center at https://eosweb.larc.nasa.gov/project/misr/misr_table.
Conventions	CF-1.6

Table 4 – File Attributes

Attribute Name	Definition	Data Type	Units	Valid Range
Local_granule_id	Name of this file	String	n/a	
Local_version_id	Software version identifier	String	n/a	
PGE_version	Version of the PGE used to generate this file	String	n/a	
Range_beginning_time Range_ending_time	Time range covered by this product	String	UTC	ISO 8601 format, e.g. 2004-06-30T21:17:11.711120Z
Software_version_information	Software version information	String	n/a	
Software_version_tag	Tag identifying software version	String	n/a	
Software_build_date	Date and time of software build	String	n/a	ISO 8601 format, e.g. 2017-03-07T00:07:01Z
Runtime_environment_information	Information about PGE runtime environment	String	n/a	
Input_files	List of input files used in data processing	String	n/a	

Table 5 – Aerosol_Parameter_Average Dimensions

Dimension Name	Description	Data Type	Units	Valid Range
Longitude	Longitude at the center of each grid cell	64-bit float	degrees east	-180 to 180
Latitude	Latitude at the center of each grid cell	64-bit float	degrees north	-90 to 90
Band	Spectral band	string	n/a	0: blue 446 nm 1: green 558 nm 2: red 672 nm 3: nir 867 nm
Optical_Depth_Range	Range of aerosol optical depth (AOD) at 550 nm in each bin. Fields with this dimension are binned according the 550 nm AOD reported in the Level 2 *Aerosol_ Optical_Depth* field.	string	n/a	0: all 1: less than 0.05 2: 0.05 to 0.15 3: 0.15 to 0.25 4: 0.25 to 0.4 5: 0.4 to 0.6 6: 0.6 to 0.8 7: 0.8 to 1.0 8: greater than 1.0
Coefficient	Spectral AOD scaling coefficient. Spectral AOD scaling coefficients are parameters of a second order polynomial fit to the spectral AODs such that $AOD(\lambda) = c_1 \lambda^2 + c_2 \lambda + c_3$, where λ is the wavelength in μm.	string	n/a	0: c1 1: c2 2: c3
Algorithm_Type	Indicates which type of Level 2 aerosol retrieval algorithm was performed	string	n/a	0: no retrieval 1: water 2: land
Retrieval_Success_Type	Indicates whether a Level 2 aerosol retrieval was successful	string	n/a	0: success 1: fail

Table 6 – Aerosol_Parameter_Average Fields

Field Name Parameter Description	**Dimensions**	**Data Type**	**Units**	**Flag Values**
Absorbing_Optical_Depth Average of AOD × (1-SSA), reported at 550 nm, where SSA is retrieved single scattering albedo at 550 nm	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Absorbing_Optical_Depth_Count Number of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit integer	count	0 = Fill
Absorbing_Optical_Depth_Standard_Deviation Standard deviation of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Aerosol_Optical_Depth Average of AOD at 550 nm	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Aerosol_Optical_Depth_Count Number of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit integer	count	0 = Fill
Aerosol_Optical_Depth_Standard_Deviation Standard deviation of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Small_Mode_Aerosol_Optical_Depth Average AOD fraction at 550 nm due to small mode aerosols (particle radius < 0.35 μm)	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Small_Mode_Aerosol_Optical_Depth_Count Number of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit integer	count	0 = Fill
Small_Mode_Aerosol_Optical_Depth_Standard_Deviation Standard deviation of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Medium_Mode_Aerosol_Optical_Depth Average AOD fraction at 550 nm due to medium mode aerosols (particle radius 0.35 – 0.7 μm)	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Medium_Mode_Aerosol_Optical_Depth_Count Number of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit integer	count	0 = Fill
Medium_Mode_Aerosol_Optical_Depth_Standard_Deviation Standard deviation of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill

Table 6 – Aerosol_Parameter_Average Fields

Large_Mode_Aerosol_Optical_Depth Average AOD fraction at 550 nm due to large mode aerosols (particle radius > 0.7 μm)	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Large_Mode_Aerosol_Optical_Depth_ Count Number of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit integer	count	0 = Fill
Large_Mode_Aerosol_Optical_Depth_ Standard_Deviation Standard deviation of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Nonspherical_Aerosol_Optical_Depth Average AOD fraction at 550 nm due to nonspherical aerosols	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Nonspherical_Aerosol_Optical_Depth_ Count Number of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit integer	count	0 = Fill
Nonspherical_Aerosol_Optical_Depth_ Standard_Deviation Standard deviation of samples included in average	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Spectral_AOD_Scaling_Coefficient Parameters of a second order polynomial fit to the averaged spectral AODs such that $AOD(\lambda) = c_1 \lambda^2 + c_2 \lambda + c_3$ where λ is the wavelength in μm	Latitude, Longitude, Optical Depth Range, Coefficient	32-bit float	n/a	-9999.0 = Fill
Spectral_AOD_Scaling_Coefficient_ Count Number of samples included in average	Latitude, Longitude, Optical Depth Range, Coefficient	32-bit integer	count	0 = Fill
Angstrom_Exponent_550_860 Ångström exponent calculated using the averaged AODs at 550 and 860 nm	Latitude, Longitude, Optical Depth Range	32-bit float	n/a	-9999.0 = Fill
Aerosol_Optical_Depth_Per_Band AOD in each of the 4 MISR spectral bands calculated using the averaged Spectral_AOD_Scaling_ Coefficient	Latitude, Longitude, Optical Depth Range, Band	32-bit float	n/a	-9999.0 = Fill
Aerosol_Optical_Depth_Per_Band_ Count Number of samples included in average	Latitude, Longitude, Optical Depth Range, Band	32-bit integer	count	0 = Fill
Absorbing_Aerosol_Optical_Depth_Per Band Average of AOD × (1-SSA), reported per MISR spectral band, where SSA is the average single scattering albedo per band	Latitude, Longitude, Optical Depth Range, Band	32-bit float	n/a	-9999.0 = Fill

Table 6 – Aerosol_Parameter_Average Fields

Absorbing_Aerosol_Optical_Depth_Per_Band_Count Number of samples included in average	Latitude, Longitude, Optical Depth Range, Band	32-bit integer	count	0 = Fill
Algorithm_Type_Count Count of occurrences for each algorithm type	Latitude, Longitude, Algorithm Type, Retrieval Success Type	32-bit integer	count	0 = Fill
Average_Fill_Flag Indicates geographical extent of MISR blocks processed	Latitude, Longitude	8-bit integer	n/a	0 = not processed 1 = processed

Table 7 – Source_file Contents

Field Name Parameter Description	**Dimensions**	**Data Type**	**Units**	**Valid Range**
Index Common dimension shared by all fields in this group	Index	32-bit integer	n/a	positive integer
Orbit_Number Terra orbit number	Index	32-bit integer	n/a	1 to 999999
Path_Number Path number of the Space Oblique Mercator (SOM) projection for this Terra orbit	Index	32-bit integer	n/a	1 to 233
Local_Granule_Id Name of input product	Index	string	n/a	e.g. MISR_AM1_CGAS_P030_O091953_F15_0018.nc
Local_Version_Id Version information from input product	Index	string	n/a	e.g. MISR_EXEC_VERSION: V6.0.7 MISR_EXEC_NAME: pge11c_main

Table 8 – Time_of_Observations_Aerosol_Parameter_Average Contents

Field Name Parameter Description	**Dimensions**	**Data Type**	**Units**	**Valid Range**
Index Common dimension shared by all fields in this group	Index	32-bit integer	n/a	positive integer
Latitude_index 0-based index of grid cell on latitude axis	Index	32-bit integer	n/a	0 to 359
Longitude_index 0-based index of grid cell on longitude axis	Index	32-bit integer	n/a	0 to 719
Orbit_number Terra orbit number	Index	32-bit integer	n/a	1 to 999999
Path_number Path number of the SOM projection for this Terra orbit	Index	32-bit integer	n/a	1 to 233
Year Average acquisition time (UTC) of observations contributing to this grid cell	Index	32-bit integer	n/a	4-digit year
Month Average acquisition time (UTC) of observations contributing to this grid cell	Index	32-bit integer	n/a	1 to 12
Day Average acquisition time (UTC) of observations contributing to this grid cell	Index	32-bit integer	n/a	1 to 31
Hour Average acquisition time (UTC) of observations contributing to this grid cell	Index	32-bit integer	n/a	0 to 23
Minute Average acquisition time (UTC) of observations contributing to this grid cell	Index	32-bit integer	n/a	0 to 59

3 Appendix

3.1 ACRONYM LIST

AOD.....Aerosol Optical Depth
CF .....Climate and Forecast
CGAS.....Component Global Aerosol
DAAC .....Distributed Active Archive Center
ECS .....EOSDIS Core System
EOS.....Earth Observing System
EOSDIS .....Earth Observing System Data and Information System
ESDT .....Earth Science Data Type
GSFC .....Goddard Space Flight Center
HDF .....Hierarchical Data Format
HDF-EOS .....Hierarchical Data Format for EOS
ISO.....International Organization for Standardization
JPL .....Jet Propulsion Laboratory
LaRC.....Langley Research Center
MISR.....Multi-angle Imaging SpectroRadiometer
NASA .....National Aeronautics and Space Administration
NetCDF.....Network Common Data Format
PGE.....Product Generation Executable
RCCT.....Radiometric Camera-by-camera Cloud mask Threshold
SCF .....Science Computing Facility
SDP.....Science Data Processing
SOM.....Space-Oblique Mercator
SSA.....Single Scattering Albedo
TASC .....Terrestrial Atmosphere and Surface Climatology
UTC .....Coordinated Universal Time